Program Features

Frey's Inquiry Investigations™ *Chemistry – A Closer Look at Matter* engages your students in active and meaningful learning. Each of the four units in the program focuses on a different theme and contains an exciting collection of classroom-tested activities that let students experience the wonders of science through direct, hands-on experience.

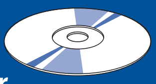
These standards-based units link to core science concepts, making them an excellent complement to your existing curriculum. Best of all, you won't need a strong background in science to use this program—the comprehensive Curriculum Guide that comes with the module provides teacher-friendly instructions on how to teach the activities.

Each Unit includes

- Comprehensive investigation literature with planning and preparation tips, step-by-step instructions, expected outcomes, cross-curricular integration, and assessment strategies.
- A reproducible Student Guide for each unit with complete background information, step-by-step procedures, data tables, analysis questions, and options for open-ended student-designed investigations that challenge students to use their critical thinking skills. Also included are related websites and *Read More About It* sources for students to obtain additional information.
- A collection of safe and fun inquiry-based lab investigations with real-world applications.
- Enough high-quality science materials for a class of up to 40 students working in groups.
- A handy Storage Center to neatly store all materials.

The Curriculum Guide includes

- Comprehensive, unit-specific teacher and student guides.
- Materials lists, a comprehensive Glossary, Useful Equivalents, Symbols, and Equations, Science Safety, and How to Record, Analyze, and Report Data.
- Two Comprehensive Inquiry Activities—Water Purification and Demonstrating Conservation of Mass.



Also included with the Inquiry Investigations™ Module *Chemistry – A Closer Look at Matter* is the Curriculum Resource CD-ROM*, which includes…

Content Tutorials:

- Topic-related content featuring detailed illustrations that cover key concepts in chemistry.
- Hyper-linked glossary of key concepts and terms.

Assessment Monitoring:

- Test questions that can be accessed in either Practice or Test Mode; questions allow students to demonstrate content knowledge.
- Customized tests and worksheets with five question types (essay, multiple choice, concept map, matching, and labeling), as well as dynamic web-deliverable multi-media tutorials and presentations.

Correlation to National and State Science Standards:

- Key concepts correlated to the National Science Education Standards (NSES) and a link to the Frey Scientific website for selected State standards.

Teacher Resources:

- Image gallery containing printable illustrations and images relating to a chemistry topic area.
- Dynamic animations that reinforce key concepts in ecology.
- Experimental results section that provides useful teacher tips for each activity as well as in-depth experimental data analysis. Where applicable, graphs, tables, and images are provided to enhance each activity.

Virtual Laboratory—Titrating an Acid of Unknown Concentration

- Explore the object-based virtual lab environment. The virtual lab allows students to interactively perform every step of the lab activity by manipulating lab equipment on their virtual workbench.
- Use the electronic notebook to record and analyze results.

**System Requirements: Windows 2000 or higher, VISTA-compatible, Mac 9.2 or higher (including OSX), 128 MB RAM.*

The Curriculum Guide contains the following sections – Teacher Guide, Appendix, Student Resources, and a Curriculum Resource CD-ROM. Each section has the same general format, let's take a closer look –

A Closer Look at the Teacher Guide…

Science Concepts and Skills

- Overview of key concepts and skills presented in each lab

Science Standards

- A list of the National Science Education Standards covered in each lab

Materials

- Comprehensive list of the materials needed for each lab

Time Requirements

- Amount of time needed for preparation and activities

Safety and Disposal

- Tips for safe disposal of waste materials and student safety

Curriculum Resource CD-ROM

- Additional resources found on the Curriculum Resource CD-ROM

Pre-lab Preparation

- Overview of any necessary pre-lab preparation

Teacher Guide

Science Concepts and Skills

- Analytical thinking
- Making observations and inferences
- Experimental design
- Matter
- Mass
- Atoms
- States of matter—solid, liquid, and gas
- pH
- Evaporation, melting, condensation, freezing
- Kinetic energy
- Temperature

National Science Standards

Standard A – Science as Inquiry

A1	Identify questions that can be answered through scientific investigations
A2	Design and conduct a scientific investigation
A3	Use appropriate tools and techniques to gather, analyze, and interpret data
A4	Develop descriptions, explanations, predictions, and models using evidence
A5	Think critically and logically to make the relationships between evidence and explanations
A6	Recognize and analyze alternative explanations and predictions
A7	Communicate scientific procedures and explanations
A9	Understandings about scientific inquiry

Standard B – Physical Science

B2	Structure and properties of matter
B6	Interactions of energy and matter

Safety and Disposal

Instruct students to follow proper lab safety techniques. Have students wear safety goggles, gloves, and a lab apron when working with any chemicals. Students should keep their hands away from their face and mouth. Have students wash their hands before leaving the laboratory.

Liquid materials may be flushed down the drain with copious amounts of water. Solid materials may be disposed of in the trash.

Curriculum Correlation

See the *Curriculum Resource CD-ROM* for a correlation to the National Science Education Standards (NSES). Visit the Frey Scientific website (**www.freyscientific.com/inquiryinvestigations**) for selected state correlations.

See the **Curriculum Resource CD-ROM** to…
- Prepare web deliverable content
- Create assessment questions
- Explore a virtual lab

Teacher Guide

Lab Materials List

20	Cups, medicine
10	Magnifying glasses
1 pc.	Paper, construction, black, 8½" × 11"
10	Pipets, plastic, 1 mL
10	Salt, packets
1	Sodium bicarbonate, 10 g
10	Syringes, 3 mL
1	Test strips, pH, p/100
2	Vinegar, 30 mL

Teacher-Provided Items

	Aprons (per student)
1	Beaker, 100 mL
	Gloves (per student)
	Safety goggles (per student)
1 pr.	Scissors
1	Tape, roll
	Water

Time Requirements

Activity 1: Classifying Matter	
Pre-lab Preparation:	10 minutes
Activity:	45 minutes
Activity 2: Exploring Changes in Matter	
Pre-lab Preparation:	10 minutes
Activity:	45 minutes

Pre-lab Preparation

Activity 1

Enough materials are provided for a class of forty students working in 10 groups of four. Divide your class into groups accordingly.

Cut the 8½" × 11" piece of black construction paper into ten 2" × 4" pieces. Distribute one to each group.

Add 100 mL of water to a plastic cup or 100 mL beaker. Place it in a central distribution location so it is easily accessible by students.

Activity 2

Enough materials are provided for a class of forty students working in 10 groups of four. Divide your class into groups accordingly.

Dispense approximately 1 g of sodium bicarbonate to each of 10 medicine cups. Label each as sodium bicarbonate. Dispense approximately 5 mL of vinegar to each of 10 different medicine cups. Label each as vinegar. Distribute one of each cup to each group.

Unit 2 | Lab 3: Matter 47

A Closer Look at the Teacher Guide…

Objective

- Specific student goals of the activity

What you need

- Specific materials used in each activity

Safety and Disposal

- Important safety information specifically related to each activity

What to do

- Teacher friendly step-by-step procedures for each activity

Cross-Curricular Integration

- Suggestions of how to relate the key concepts of the lab to other disciplines

Recording Observations

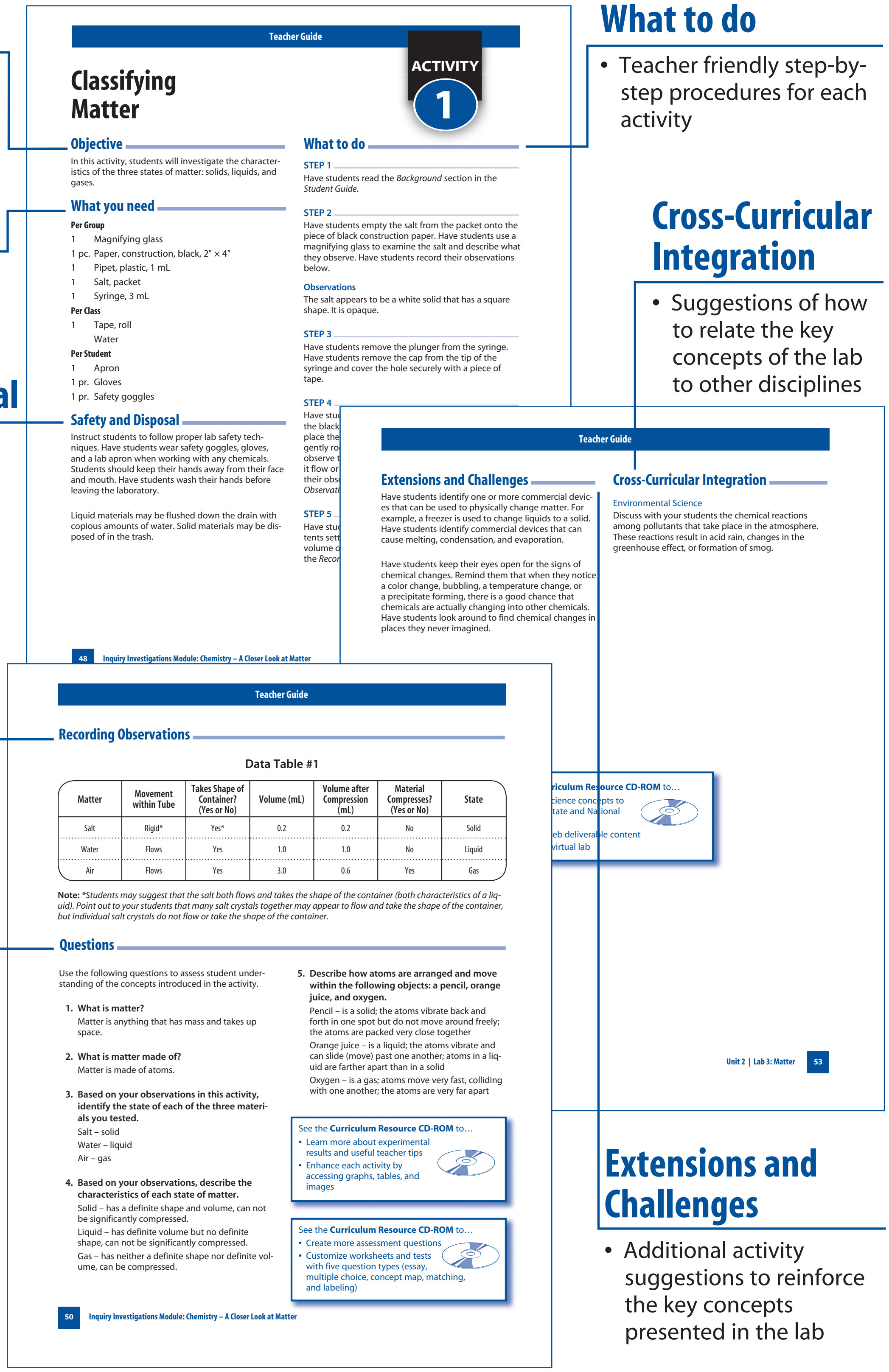
- Sample student data for each activity

Questions

- Questions to assess student understanding of the activity

Extensions and Challenges

- Additional activity suggestions to reinforce the key concepts presented in the lab



Teacher Guide

ACTIVITY 1

Classifying Matter

Objective

In this activity, students will investigate the characteristics of the three states of matter: solids, liquids, and gases.

What you need

Per Group

1 Magnifying glass
1 pc. Paper, construction, black, 2" × 4"
1 Pipet, plastic, 1 mL
1 Salt, packet
1 Syringe, 3 mL

Per Class

1 Tape, roll
Water

Per Student

1 Apron
1 pr. Gloves
1 pr. Safety goggles

Safety and Disposal

Instruct students to follow proper lab safety techniques. Have students wear safety goggles, gloves, and a lab apron when working with any chemicals. Students should keep their hands away from their face and mouth. Have students wash their hands before leaving the laboratory.

Liquid materials may be flushed down the drain with copious amounts of water. Solid materials may be disposed of in the trash.

What to do

STEP 1

Have students read the *Background* section in the *Student Guide*.

STEP 2

Have students empty the salt from the packet onto the piece of black construction paper. Have students use a magnifying glass to examine the salt and describe what they observe. Have students record their observations below.

Observations

The salt appears to be a white solid that has a square shape. It is opaque.

STEP 3

Have students remove the plunger from the syringe. Have students remove the cap from the tip of the syringe and cover the hole securely with a piece of tape.

STEP 4

Have stu… the black… place the… gently ro… observe t… it flow or… their obs… *Observati…*

STEP 5

Have stu… tents sett… volume o… the *Recor…*

48 Inquiry Investigations Module: Chemistry – A Closer Look at Matter

Teacher Guide

Extensions and Challenges

Have students identify one or more commercial devices that can be used to physically change matter. For example, a freezer is used to change liquids to a solid. Have students identify commercial devices that can cause melting, condensation, and evaporation.

Have students keep their eyes open for the signs of chemical changes. Remind them that when they notice a color change, bubbling, a temperature change, or a precipitate forming, there is a good chance that chemicals are actually changing into other chemicals. Have students look around to find chemical changes in places they never imagined.

Cross-Curricular Integration

Environmental Science

Discuss with your students the chemical reactions among pollutants that take place in the atmosphere. These reactions result in acid rain, changes in the greenhouse effect, or formation of smog.

…riculum Resource CD-ROM to…
…cience concepts to …tate and National
…eb deliverable content
…virtual lab

Unit 2 | Lab 3: Matter 53

Teacher Guide

Recording Observations

Data Table #1

Matter	Movement within Tube	Takes Shape of Container? (Yes or No)	Volume (mL)	Volume after Compression (mL)	Material Compresses? (Yes or No)	State
Salt	Rigid*	Yes*	0.2	0.2	No	Solid
Water	Flows	Yes	1.0	1.0	No	Liquid
Air	Flows	Yes	3.0	0.6	Yes	Gas

Note: **Students may suggest that the salt both flows and takes the shape of the container (both characteristics of a liquid). Point out to your students that many salt crystals together may appear to flow and take the shape of the container, but individual salt crystals do not flow or take the shape of the container.*

Questions

Use the following questions to assess student understanding of the concepts introduced in the activity.

1. **What is matter?**
   Matter is anything that has mass and takes up space.
2. **What is matter made of?**
   Matter is made of atoms.
3. **Based on your observations in this activity, identify the state of each of the three materials you tested.**
   Salt – solid
   Water – liquid
   Air – gas
4. **Based on your observations, describe the characteristics of each state of matter.**
   Solid – has a definite shape and volume, can not be significantly compressed.
   Liquid – has definite volume but no definite shape, can not be significantly compressed.
   Gas – has neither a definite shape nor definite volume, can be compressed.
5. **Describe how atoms are arranged and move within the following objects: a pencil, orange juice, and oxygen.**
   Pencil – is a solid; the atoms vibrate back and forth in one spot but do not move around freely; the atoms are packed very close together
   Orange juice – is a liquid; the atoms vibrate and can slide (move) past one another; atoms in a liquid are farther apart than in a solid
   Oxygen – is a gas; atoms move very fast, colliding with one another; the atoms are very far apart

See the **Curriculum Resource CD-ROM** to…
- Learn more about experimental results and useful teacher tips
- Enhance each activity by accessing graphs, tables, and images

See the **Curriculum Resource CD-ROM** to…
- Create more assessment questions
- Customize worksheets and tests with five question types (essay, multiple choice, concept map, matching, and labeling)

50 Inquiry Investigations Module: Chemistry – A Closer Look at Matter

A Closer Look at the Appendix…

Laboratory Notebook

- Useful tips on how to record, organize, and understand data

The Laboratory Notebook: Recording, Analyzing, and Reporting Data

Data sets are unbiased information gathered through the scientific process that can lead to knowledge and understanding. To be useful, data must be recorded, organized, graphed, analyzed, and reported.

Recording Data

Science deals with verifiable observations. All scientists must keep clear and accurate records of their observations. It is critical that these notebook recordings are made at the time of observation.

Recording data can be done manually through the reading of an instrument, such as a thermometer, and writing down measurements in a lab notebook or data book. Some data measurement probes and instruments (temperature, balance, pH, dissolved oxygen to name a few) can sample and transmit data to a computer for storage in a data table.

At times, your investigation may require the use of a video or photo camera to record visual information. Try to include some dimensional reference (a ruler or other feature) in your shots to provide the correct perspective. Digital photo cameras and scanners allow an investigator to capture experimental results.

Organizing Data

Make sure data sets are presented in tables listed in correct relation to each other. Sometimes your investigations may call for the collection of very large data sets. One way to manage this pile of data is through a database—a large, complex list of facts and information. A database can be a card file or an electronic program that can both recall and merge data. FileMaker Pro (by FileMaker, Inc) or Excel (by Microsoft) are powerful database programs that combine database management and desktop-to-Web network publishing

reproducibility of a result. For example, if you measure a quantity several times and the values agree closely with one another, your measurement is precise. Accuracy describes how close a measured value is to the true or known value. The closer a measured value is to the true value, the more accurate it is. Let's investigate this further.

For example, examine the data sets below.

Procedure 1:	20.1
	20.1
	20.2
	20.0
Procedure 2:	24.5
	25.6
	26.1
	25.1

If the true value is 25.3, then data collected from procedure 2 is more accurate but less precise than the data collected from procedure 1. In this case the precision is poor but the accuracy is good. An ideal procedure is both accurate and precise.

Data Books

The best method of record-keeping is to record observations in a laboratory notebook or data book. Ideally, this should be a stiff-covered book, permanently bound, not loose-leaf, preferably with square grid pages.

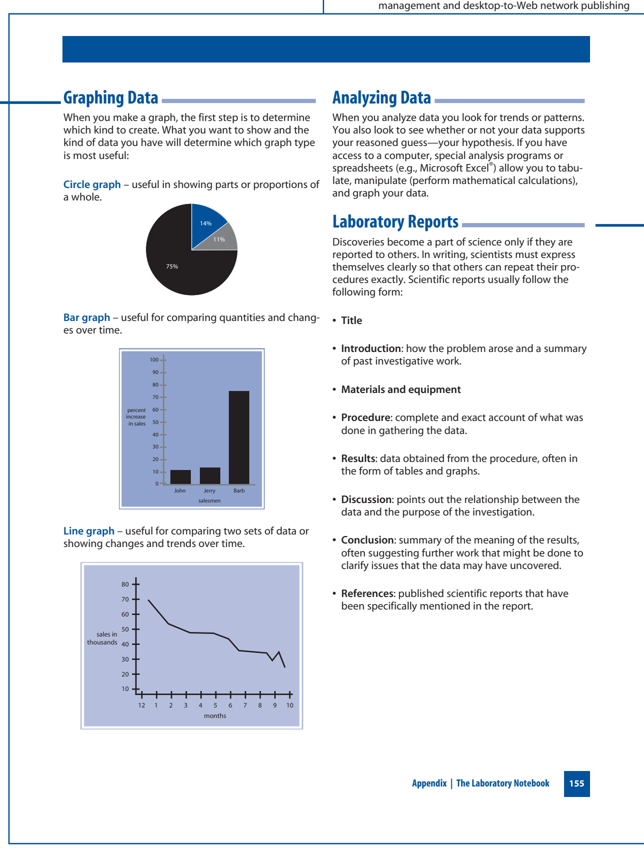
Keep records in a diary form, recording the date first. If you make observations for two or more investigations on the same day, use numbers or abbreviations of the itles as subheadings.

ata may be recorded as words. In the laboratory, time s short. Make notes as brief as possible—but to the oint. You may choose to sketch your observations. rawings, digital images, and digital video are all useful ata recording techniques.

er

Graphing Data

- Examples of ways to graphically present data



Graphing Data

When you make a graph, the first step is to determine which kind to create. What you want to show and the kind of data you have will determine which graph type is most useful:

Circle graph – useful in showing parts or proportions of a whole.

Bar graph – useful for comparing quantities and changes over time.

Line graph – useful for comparing two sets of data or showing changes and trends over time.

Analyzing Data

When you analyze data you look for trends or patterns. You also look to see whether or not your data supports your reasoned guess—your hypothesis. If you have access to a computer, special analysis programs or spreadsheets (e.g., Microsoft Excel®) allow you to tabulate, manipulate (perform mathematical calculations), and graph your data.

Laboratory Reports

Discoveries become a part of science only if they are reported to others. In writing, scientists must express themselves clearly so that others can repeat their procedures exactly. Scientific reports usually follow the following form:

- **Title**
- **Introduction**: how the problem arose and a summary of past investigative work.
- **Materials and equipment**
- **Procedure**: complete and exact account of what was done in gathering the data.
- **Results**: data obtained from the procedure, often in the form of tables and graphs.
- **Discussion**: points out the relationship between the data and the purpose of the investigation.
- **Conclusion**: summary of the meaning of the results, often suggesting further work that might be done to clarify issues that the data may have uncovered.
- **References**: published scientific reports that have been specifically mentioned in the report.

Laboratory Reports

- General outline for scientific reports

A Closer Look at the Appendix…

Useful Equivalents, Symbols, and Equations

- Quick reference guide of common conversions, symbols, and equations

Useful Equivalents, Symbols, and Equations

Equivalents

Mass

1 kilogram (kg)	= 1,000 grams (g)
1 gram (g)	= 0.001 kg
1 milligram (mg)	= 0.001 g
1 microgram (µg)	= 0.000001 g
1 nanogram (ng)	= 0.000000001 g

Liquid Volume

1 kiloliter (kL)	= 1,000 L
1 milliliter (mL)	= 0.001 L
1 mL	= 1 cm^3
1 microliter (µL)	= 0.000001 L

Length

1 kilometer (km)	= 1,000 m
1 centimeter (cm)	= 0.01 m
1 millimeter (mm)	= 0.001 m
1 micrometer (µm)	= 0.000001 m

Temperature

$T_{Fahrenheit} = (9/5 \times T_{Celsius}) + 32$

$T_{Celsius} = 5/9(T_{Fahrenheit} - 32)$

Common Symbols

Quantity	Common Symbol
Temperature	T
Density	ρ
Chang	Δ
Mass	*m*
Molar	*M*
Mole	mol
Millimole	mmol
Volume	V
Atomic mass unit	amu
Pressure	*P*
Avogadro's number	N_A (6.022137 × 10^{23} mol)
Ideal gas law constant	*R*

Common Equations

Quantity	Formula	SI Unit
Density	= mass/volume	
Specific gravity	= density of sample/density of water*	

** density of water = 1 g/cm³*

at Matter

Glossary

- Comprehensive glossary of key terms

Glossary

A

Acid Compound that releases hydrogen ions (H+) into water, giving it a pH below 7.0.

Activation energy Smallest amount of energy needed to start a chemical reaction.

Aeration The addition of air to water; oxygen is added to a sample.

Amphoteric The ability of a substance to act as both an acid and a base; water is amphoteric.

Anion A negatively (–) charged ion.

Atom Smallest particle of an element that still has all the properties of that element.

Atomic mass Number of protons plus the number of neutrons in the nucleus of an atom.

Atomic number Number of protons in the nucleus of an atom.

Atomic theory Idea that all matter is made of atoms.

B

Base Compound that accepts a hydrogen ion (H^+) in water, giving it a pH above 7.0.

Bioremediation The use of biological agents, such as bacteria or plants, to remove or neutralize contaminants, as in polluted soil or water.

Boiling point Temperature at which a liquid becomes a gas.

Boyle's law A law that states that the volume of a fixed amount of gas at a constant temperature is inversely proportional to the gas pressure.

Brønsted-Lowry theory A theory that describes acids as hydrogen-ion donors and bases as hydrogen-ion acceptors.

C

Catalyst A substance that speeds up a chemical reaction but is not changed during the reaction.

Cation A positively (+) charged ion.

Chemical bond Force that holds two or more atoms together.

Chemical change Change in matter in which one or more new substances form; also called a *chemical reaction*.

Chemical equation Symbols that show how matter changes during a chemical reaction.

Chemical formula Group of symbols that shows the makeup of a compound, for example NaCl (sodium chloride), or common table salt.

Chemical property Property of a substance that can be used to identify it and that describes how that substance reacts with other substances.

Chemical reaction Change in matter in which two or more elements or compounds (reactants) combine to form different compounds or elements (products).

Coagulation The process of suspended solid particles "sticking" together in a solution.

Colloid Heterogeneous mixture with properties that are between those of a solution and a suspension; particles are not dissolved, but do not settle out.

Combustibility Substance's ability to burn.

168 Inquiry Investigations Module: Chemistry – A Closer Look at Matter

A Closer Look at the Student Guide…

Objectives

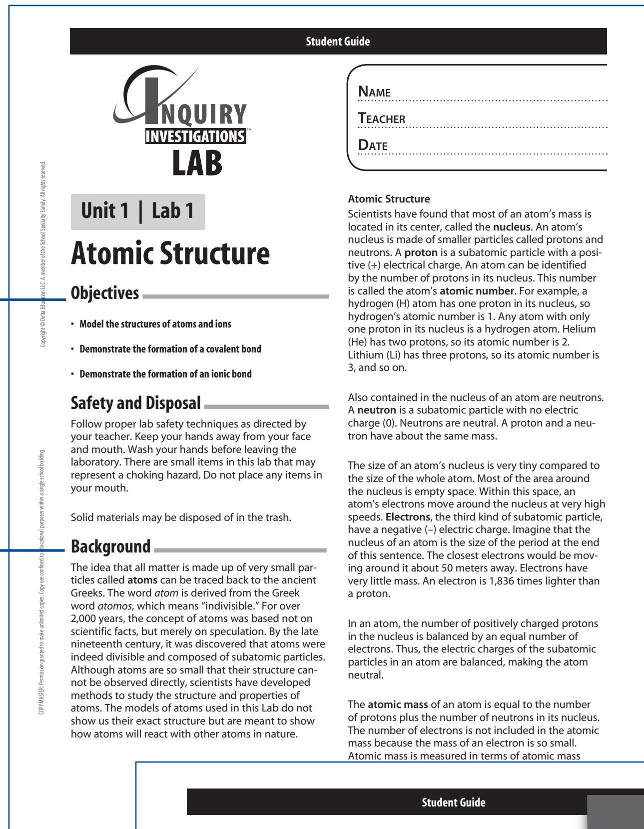
- Key concepts and student goals for the lab

Background

- Science information related to the lab topic

What to do

- Step-by-step procedures for each activity



Student Guide

INQUIRY INVESTIGATIONS™ LAB

NAME

TEACHER

DATE

Unit 1 | Lab 1

Atomic Structure

Objectives

- Model the structures of atoms and ions
- Demonstrate the formation of a covalent bond
- Demonstrate the formation of an ionic bond

Safety and Disposal

Follow proper lab safety techniques as directed by your teacher. Keep your hands away from your face and mouth. Wash your hands before leaving the laboratory. There are small items in this lab that may represent a choking hazard. Do not place any items in your mouth.

Solid materials may be disposed of in the trash.

Background

The idea that all matter is made up of very small particles called **atoms** can be traced back to the ancient Greeks. The word *atom* is derived from the Greek word *atomos*, which means "indivisible." For over 2,000 years, the concept of atoms was based not on scientific facts, but merely on speculation. By the late nineteenth century, it was discovered that atoms were indeed divisible and composed of subatomic particles. Although atoms are so small that their structure cannot be observed directly, scientists have developed methods to study the structure and properties of atoms. The models of atoms used in this Lab do not show us their exact structure but are meant to show how atoms will react with other atoms in nature.

Atomic Structure

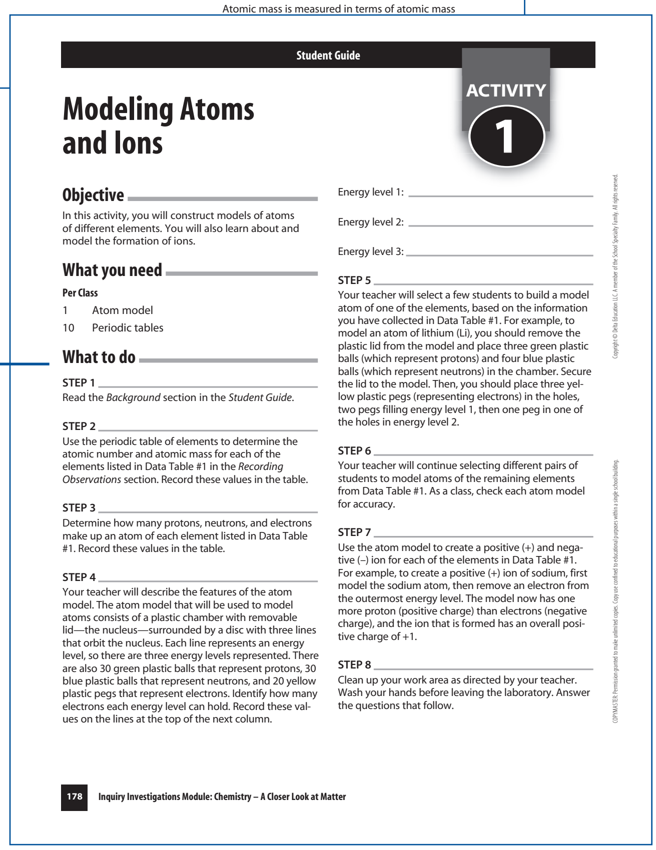
Scientists have found that most of an atom's mass is located in its center, called the **nucleus**. An atom's nucleus is made of smaller particles called protons and neutrons. A **proton** is a subatomic particle with a positive (+) electrical charge. An atom can be identified by the number of protons in its nucleus. This number is called the atom's **atomic number**. For example, a hydrogen (H) atom has one proton in its nucleus, so hydrogen's atomic number is 1. Any atom with only one proton in its nucleus is a hydrogen atom. Helium (He) has two protons, so its atomic number is 2. Lithium (Li) has three protons, so its atomic number is 3, and so on.

Also contained in the nucleus of an atom are neutrons. A **neutron** is a subatomic particle with no electric charge (0). Neutrons are neutral. A proton and a neutron have about the same mass.

The size of an atom's nucleus is very tiny compared to the size of the whole atom. Most of the area around the nucleus is empty space. Within this space, an atom's electrons move around the nucleus at very high speeds. **Electrons**, the third kind of subatomic particle, have a negative (–) electric charge. Imagine that the nucleus of an atom is the size of the period at the end of this sentence. The closest electrons would be moving around it about 50 meters away. Electrons have very little mass. An electron is 1,836 times lighter than a proton.

In an atom, the number of positively charged protons in the nucleus is balanced by an equal number of electrons. Thus, the electric charges of the subatomic particles in an atom are balanced, making the atom neutral.

The **atomic mass** of an atom is equal to the number of protons plus the number of neutrons in its nucleus. The number of electrons is not included in the atomic mass because the mass of an electron is so small. Atomic mass is measured in terms of atomic mass



Student Guide

ACTIVITY 1

Modeling Atoms and Ions

Objective

In this activity, you will construct models of atoms of different elements. You will also learn about and model the formation of ions.

What you need

Per Class

1 Atom model

10 Periodic tables

What to do

STEP 1

Read the *Background* section in the *Student Guide*.

STEP 2

Use the periodic table of elements to determine the atomic number and atomic mass for each of the elements listed in Data Table #1 in the *Recording Observations* section. Record these values in the table.

STEP 3

Determine how many protons, neutrons, and electrons make up an atom of each element listed in Data Table #1. Record these values in the table.

STEP 4

Your teacher will describe the features of the atom model. The atom model that will be used to model atoms consists of a plastic chamber with removable lid—the nucleus—surrounded by a disc with three lines that orbit the nucleus. Each line represents an energy level, so there are three energy levels represented. There are also 30 green plastic balls that represent protons, 30 blue plastic balls that represent neutrons, and 20 yellow plastic pegs that represent electrons. Identify how many electrons each energy level can hold. Record these values on the lines at the top of the next column.

Energy level 1: __________

Energy level 2: __________

Energy level 3: __________

STEP 5

Your teacher will select a few students to build a model atom of one of the elements, based on the information you have collected in Data Table #1. For example, to model an atom of lithium (Li), you should remove the plastic lid from the model and place three green plastic balls (which represent protons) and four blue plastic balls (which represent neutrons) in the chamber. Secure the lid to the model. Then, you should place three yellow plastic pegs (representing electrons) in the holes, two pegs filling energy level 1, then one peg in one of the holes in energy level 2.

STEP 6

Your teacher will continue selecting different pairs of students to model atoms of the remaining elements from Data Table #1. As a class, check each atom model for accuracy.

STEP 7

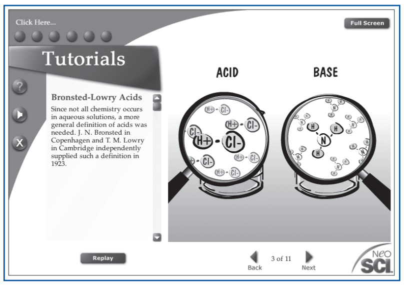
Use the atom model to create a positive (+) and negative (–) ion for each of the elements in Data Table #1. For example, to create a positive (+) ion of sodium, first model the sodium atom, then remove an electron from the outermost energy level. The model now has one more proton (positive charge) than electrons (negative charge), and the ion that is formed has an overall positive charge of +1.

STEP 8

Clean up your work area as directed by your teacher. Wash your hands before leaving the laboratory. Answer the questions that follow.

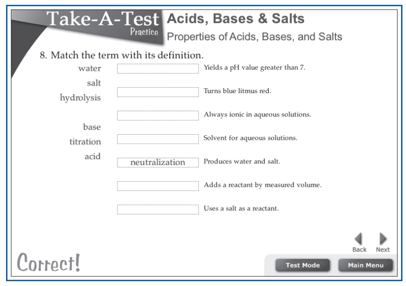
178 Inquiry Investigations Module: Chemistry – A Closer Look at Matter

A Closer Look at the Curriculum Resource CD-ROM*…



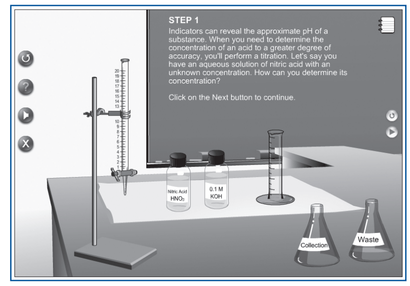
Content Tutorials

- Comprehensive tutorials offering self-paced, individualized lessons through illustrations and animations
- Hyper-linked glossary of key concepts and terms



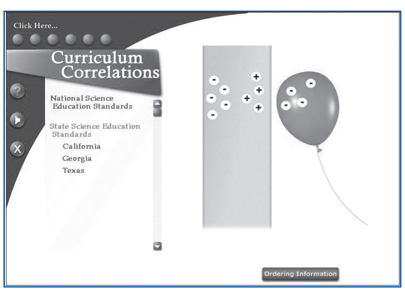
Assessment Monitoring

- Access test questions in either Practice or Test Mode to provide students with exam experience
- Create customized tests and worksheets with various question types, as well as dynamic multimedia tutorials and presentations—saving them on a disk or in web-ready format for easy Internet access



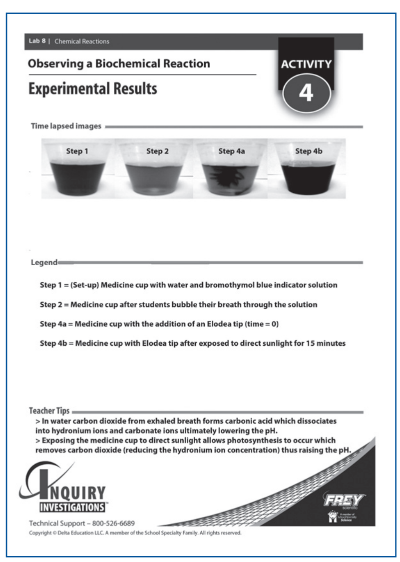
Virtual Laboratory

- Explore the object-based virtual lab environment. The virtual lab allows students to interactively perform every step of a lab activity by manipulating lab equipment on their virtual lab workbench.
- The electronic notebook allows students to record and analyze data.



Correlations to National and selected State Standards

- Key concepts correlated to the National Science Education Standards and 25 selected State standards linked to the Frey Scientific website (**www.freyscientific.com/inquiryinvestigations**)



Lab 8 | Chemical Reactions

Observing a Biochemical Reaction

ACTIVITY 4

Experimental Results

Time lapsed images

Step 1 Step 2 Step 4a Step 4b

Legend

Step 1 = (Set-up) Medicine cup with water and bromothymol blue indicator solution

Step 2 = Medicine cup after students bubble their breath through the solution

Step 4a = Medicine cup with the addition of an Elodea tip (time = 0)

Step 4b = Medicine cup with Elodea tip after exposed to direct sunlight for 15 minutes

Teacher Tips

> In water carbon dioxide from exhaled breath forms carbonic acid which dissociates into hydronium ions and carbonate ions ultimately lowering the pH.

> Exposing the medicine cup to direct sunlight allows photosynthesis to occur which removes carbon dioxide (reducing the hydronium ion concentration) thus raising the pH.

INQUIRY INVESTIGATIONS

Technical Support – 800-526-6689

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Experimental Results

- Useful teacher tips for each activity, as well as in-depth experimental data analysis
- Graphs, tables, and images are provided to enhance each activity.

*CD-ROM System Requirements: Windows 2000 or higher, VISTA-compatible, Mac 9.2 or higher (including OSX), 128 MB RAM